A Multimedia Content Adaptation Mechanism to Implement Universal Access on Learning Environment

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Abstract

Using rich types of media to create and generate lecturing materials or contents will improve the learning interest and effectiveness. When a well-organized and designed multimedia lecturing content has been completed, is it possible to be presented on different types of device? If not, the author will be requested to modify his/her content until suitable for every types of device. In this paper, we have proposed a content adaptation mechanism to implement the spirit of "**create content once, ready for universal access**". That means a mechanism to deliver adaptive content from any platform in any format to any device through any network at anytime and anywhere. We have demonstrated the performance of this mechanism. Based on our results, it can encourage author to concentrate on content designing and use our content adaptation mechanism to deliver adaptive content to different type of devices.

Keywords: *multimedia, content adaptation, universal access, CC/PP*

1. Introduction

Using rich types of media to create and generate lecturing materials or contents will improve the learning effectiveness. There are many ways to present the lecturing contents to students, likes classroom teaching, distance learning, field teaching or recorded content in VCD. With the outstanding performance which multimedia provided, e-learning gradually becomes the main trend in place of traditional teaching.

Traditional homepage can display different type of media likes static image, video, text, animation, audio, and etc. Each type of media has their dedicated features and corresponding requirements. How to get an optimized presentation is dependent on delivering a suitable formatted content which can be supported in the client. So before delivering contents to student, it is necessary to know the capability of device which will be used to display. In recently years, a lot of end devices have been developed likes, workstation, desktop, notebook, personal digital assistant, and pocket PC. No two devices have same capability on software and hardware due to their working environments. These capabilities include operation system, browser, application, screen, resolution, memory, and sound. However, a good organized content with suitable adaptation should be able to optimal presented on the user device will do a lot of improvement on learning effects. In fact, a full functional device, PC or workstation, can solve the presentation problem for all the media. Nevertheless, holding a PDA or pocket PC on the field, museum, factory, or even on the car is a more friendly choice to user. It is obviously that the device capabilities between PC and Pocket PC are very different. For example, due to the limitation of memory and storage, video can not be pre-loaded then played on the PDA even it supports the audio and true color capability.

In this paper, a content adaptation mechanism has been developed which deliver suitable content elements likes, flash, audio, video, text, or images from original resource based on client's device information.

2. Related Researches

To content, the life cycle can be divided into content adaptation, content delivery, and content presentation phases shown on Figure 1. The original spirit is to achieve "**create content once, ready for universal access**", i.e. a mechanism to create and deliver adaptive content from any platform in any format to any device through any network at anytime and anywhere. In this way, it is more efficiency and reasonable to encourage teachers and authors to spend more time to create thing really needed and not pay attention on detailed formatting matters. W3C refer such mechanism to universal access [1], [2], [3], [4], [5].

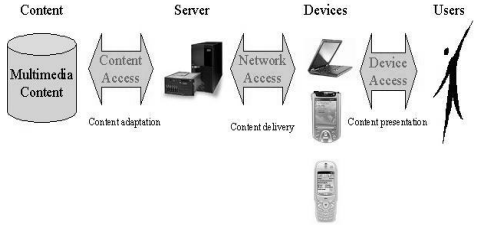

Figure 1. Lifecycle for Content

Content adaptation is a mechanism to dynamic adjusting content's components to meet the constraints of network bandwidth, user preference, and devices limitations. So it is necessary to know network, user, and device information prior to content rendering.

To acknowledge the capability of client's device, there are two approaches to implement it. The simplest one is to parse packets which are issued from client. The HTTP packets include the browser information like, MS IE, Netscape, or etc. Using the related information, it is easily to guess the type of end device. Then applied to suitable style sheet, an adaptive content can be generated and delivered to client. In this way, only use browser information to identify client device. So it can treat as coarse information which used only to recognize PDA or non-PDA device. In this approach, the detailed capability of device can not be properly defined.

The other approach is recommended by W3C, called CC/PP (Composite Capability/ Preference Profile) [6], [5]. All the software and hardware attributes or features can be detailed described in the CC/PP file. Using a parsing tool to resolve the profile, the system then will know what client is equipped. Choosing a suitable style sheet then an adaptive content will appear on the client's device.

The next issue need to be studied is the content components organization and ordering which included spatial and temporal property. Well organized contents can lead the student focus on the learning objectives. In traditional homepage, all the content components will be displayed only in spatial dimension. No temporal relation or property can be used among these content components. In fact, there are lot of temporal relation exist among the resources inherently especially in learning environment. Currently, there several solutions have been proposed. W3C recommended Synchronized Multimedia Integration Language (SMIL) enables simple authoring of interactive audiovisual presentations [8]. The others like Microsoft's HTML+TIME (Timed Interactive Multimedia Extensions) which adds timing and media synchronization to HTML pages. Using a few Extensible Markup Language (XML)-based elements and attributes, you can add images, video, and sounds to an HTML page, and synchronize them with HTML text elements over a specified amount of time [9]. So it is obviously that using these markup languages with temporal property can increase the learning content's readability.

Is it possible to display above organized multimedia contents in all devices? Especially displayed on small device, likes PAD which the students, salesman, or any others with highly mobile needs. In this paper, we are going to focus on the content adaptation applied to PDA.

3. Content Adaptation

There are many types of media content can be found on the internet. Each type of media has their specific feature and corresponding requirements. However, a well organized content with suitable adaptation will do a lot of improvement on learning effects if it can be shown properly. It is known that a XML file with XSL can provide variety of presentation. So XSL is the key for content adaptation. In other words, different XSL will provide different presentation. So a suitable style sheet which is designed based on the corresponding device's capability then would be an important issue.

3.1. System Architecture

In this paper, the proposed a content adaptation mechanism is shown on Figure 2.

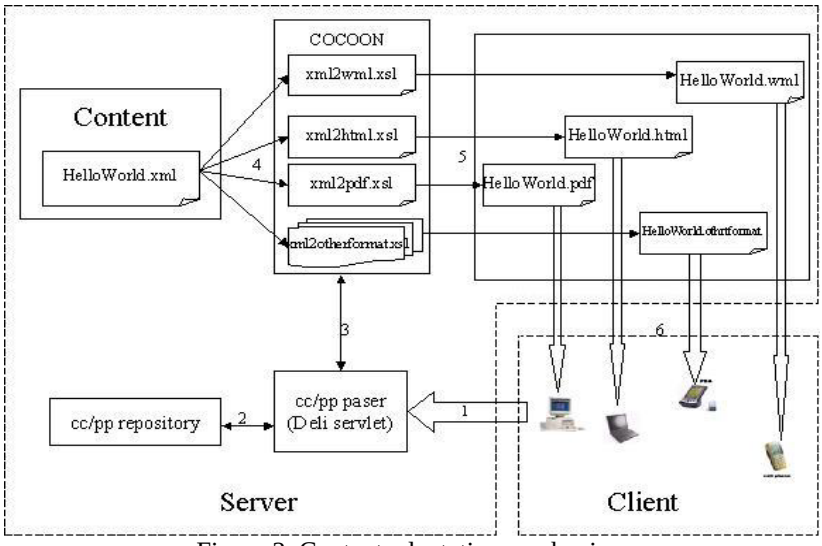

Figure 2. Content adaptation mechanism

In this system, the desired content which is expressed in XML format will be treated as the target need to be checked. Followed XML schema, it is easily found the properties of all type of resources. The CC/PP parser will parse the CC/PP files in the same time. Based on the resolved information of device, CC/PP parser will select a suitable XSL document from the library. If there is no suitable file existed, the XSLT agent will generate a special XSL file based on the resolved device information, like color capability, size of screen, and function of sound.

In general, the XSLT will handle two major works. First, determine whether these media components will be delivered to client or not. Second, if above answer is positive, proceed the adaptive process to make a friendly presentation to client based on the capability of client's device. In case present rich types of content into a small device, the following factors need to be considered:

(1) Hardware capabilities: screen size, resolution, memory requirement, and audio capability.
(2) Software capabilities: browser version, supported markup language, JAVA, and others API.

The CC/PP parser will select suitable transformation file, XSL, based on the above device information. For example, the pocket PC's operating system, i.e. M.S. windows CE, can support text, image, and streaming media components. Then in the content, same type components can be delivered to client device through an adaptive process, likes adjust the display size in vertical and horizontal axis. The resolution also can be reduced from true color to 16-bit color dependent on the capability of display card. All these works is aimed to achieve a better presentation effect.

The software environment is also included in the CC/PP file, likes version of OS, media player, and applications. CC/PP parser then will know there is a suitable media player exists or not. If not, the streaming media may not need to be delivered to client's device. In this way, the transmitted data will be kept on the necessary amount. This will also help to reduce the need of bandwidth. The browser is the last factor need to be considered. Not all the browsers can process the whole markup languages. In fact, not all the browser can not support each type of markup language, so it is necessary to develop a mechanism to transform it to an acceptable format which can be parsed by browser.

3.2. Adapting Process

For adapting content, it is necessary to render content based on the capability of student's device. The creator or author will design their content based on a completely concept or scenarios. For example, a text-based syllabus will be appeared first with the learning objective. In the same time, the teacher's pre-recorded audio file will be played. Then the others lecturing content will be played sequentially or on demand. The lecturing content also can be re-organized into basic, preliminary, or advanced categories, according to the level of student. It is easily found that there exists a strongly temporal relationship among whole content components. A good arrangement on lecturing material is the most important thing teacher need to focus on. Teacher is unnecessary to worry about how to present these contents on the PC, or NB. In this study, due to the flexibility and cost, PDA is chose to be the adaptive target. Currently, the PDA's browser has not supported the SMIL or HTML+TIME multimedia markup language. In order to implement above mentioned "**create content once, ready for universal access**", it is necessary to create a mechanism which will help author or creator to remove the features which can not be displayed on the small devices, likes PDA. The detail process is described as followed:

(1) Parsing the content and record all the detailed information about each component including types, identification, name, src, time, location, size, and etc.
(2) Determining which media component can be acceptable on the student's device.
(3) Based on the capability limitation, the corresponding reference on spatial domain will be sequentially arranged.
(4) Adjusting the presentation format for each candidate component.

It is obviously that there exist synchronization and timing relations among these components. It is necessary using an analyzing model to effectively exploit these relationships. Due to Petri Net can be used for representation the synchronization and fidelity constraints among the multimedia components, an extend Petri Net model is adopted, called MOPN (Multimedia Object Petri Net). MOPN can provide the modeling function on the duration property to analyze the temporal and sequence relation among content's components, i.e. rendering plan. [11] We will use this model to explain it. A MOPN is a triple, *MPON = (PN, D, MF)* where PN is an ordinary Petri Net, D is a duration function, and MF is set of modalities. Each component is assigned a modality and duration where modality indicates the type of player used to play this component. The duration indicates how long the component is to be played.

4. Design and Implementation

In this section, we will use multimedia to generate a learning content with temporal and sequence arrangement. The generated content will be delivered to different devices after proceed related adapting process. In our experiment, we choose Deli which parse CC/PP to detect the device's capability and personal preference on the client and also use Cocoon which support XSLT to adapt content based on CC/PP information [10], [7]. Our sever is equipped with Pentium 1.0GHz CPU and 512 MB memory. Deli and Cocoon are installed on both M.S. windows 2000 profession and Red HAT Linux 7.3 servers. The client device we tested is Compaq 3870 PDA with M.S. windows C.E. 3.0 PPC and notebook with M.S. windows 2000.

The following Figures will illustrate our approach. The original lecturing content is composed of rich types of media, likes streaming video, text description, and images, shown on Figure 3. In order to describe the detailed relation among content's components, we use Petri Net to simulate the workflows in our system. Using the Petri Net, it is easily to analyze the relationships among the resources especially the temporal properties. In Figure 4, the ordering sequence of components is shown using previous mentioned MOPN. From Figure 4, picture 1 with text 1 will appear first, then the picture 2 with text 2, and picture 3 with text3. In the meantime, streaming video will be continuously played. This content can be display on any PC or NB with browser MS IE 6.0 and above which support HTML+TIME.

Figure 3. Original content which composed of pictures, corresponding texts, and streaming video.

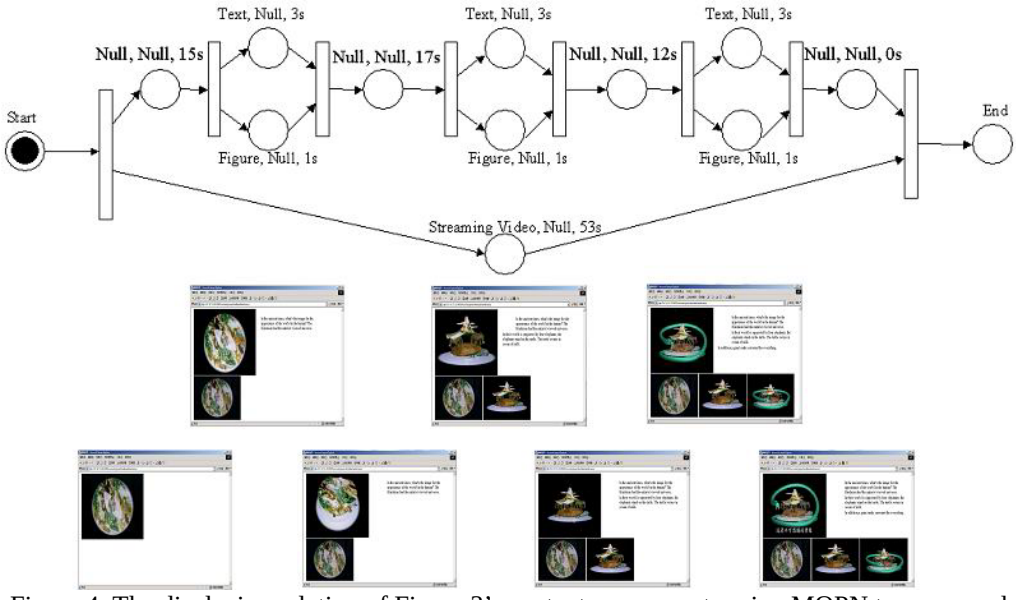

Figure 4. The displaying relation of Figure 3's content components using MOPN to expressed

We know there are still others browsers which do not support HTML+TIME. So in our system, the original content will be parsed and transformed into HTML format. During the transformation process, the time and sequence information of components will be removed. Then the component will be adapted based on the device capability. The adapted result is shown on Figure 5. From Figure 6, it can be found that the time and sequence property of component has been removed. All the components will be appeared in the same time.

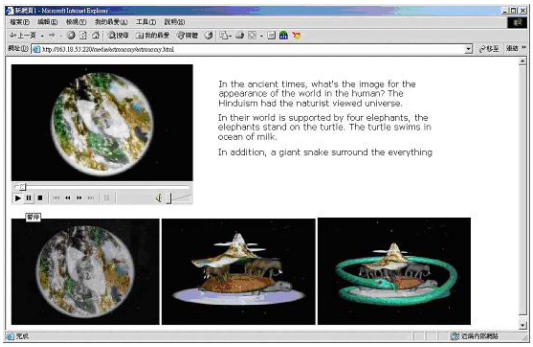

Figure 5. Adaptive content shown on MS browser 5.0 which not supporting HTML+TIME

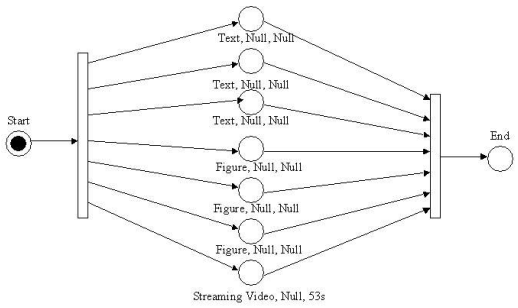

Figure 6. The displaying relation of Figure 5's content components using MOPN to expressed

Now, we will demonstrate this content can be adapted shown on the PDA. The original content still needs to be parsed first. Then time and sequence information of components will be removed. The system uses Deli to resolve device's CC/PP information and deliver to the XSL processor, i.e. COCOON, to find a suitable style sheet. The resulting content then can be shown on PDA. The adapted result is shown on Figure 7. From Figure 8, it can be found that all the picture and text components will be appeared in the same time. Only the streaming media need user sending a "click "instruction to notify system to start playing. The time and sequence property of component has been removed. It also can be seen that the presentations of pictures with corresponding text-based description has been adapted for the PDA. In this way, student can get more friendly content presentation on his device.

Figure 7. Adaptive content shown on PDA

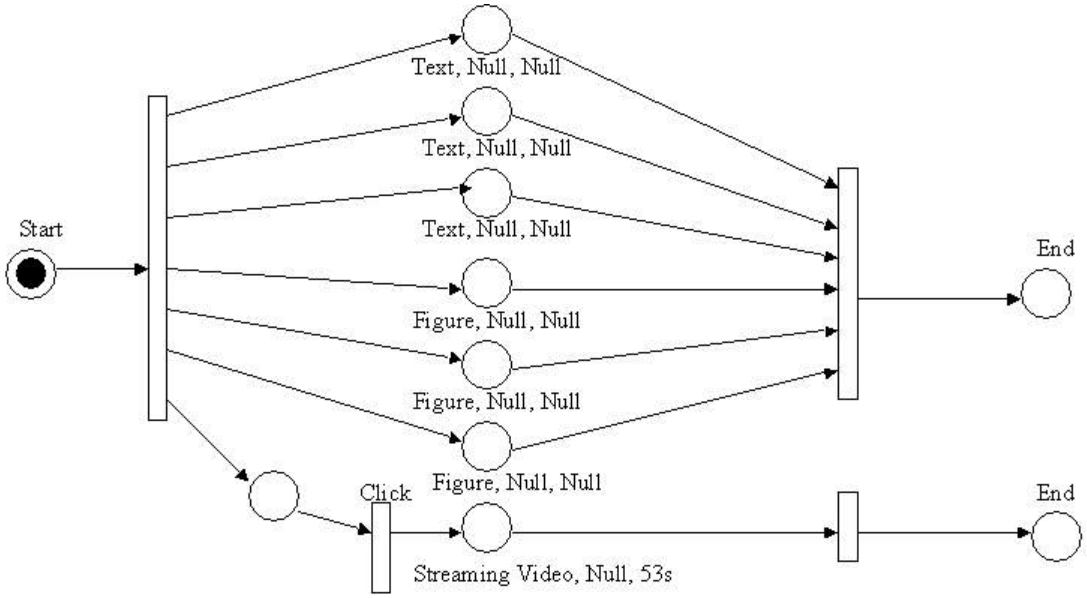

Figure8. The displaying relation of Figure 7's content components using MOPN to expressed

5. Summary

In this paper, we have proposed a content adaptation mechanism to implement the spirit of "**create content once, ready for universal access**". That is a mechanism to deliver adaptive content from any platform in any format to any device through any network at anytime and anywhere. We have demonstrated that transform the original component's feature to satisfy the requirement on device, change the presentation sequence to match the different browser requirement, and re-organized the content to achieve optimal presentation on the student's device. According to above result, we can let author to concentrate on content design and use our content adaptation mechanism to deliver adaptive content to different type of devices.

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